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PHENOLOGY OF AQUATIC DANCE FLIES (DIPTERA: EMPIDIDAE: HEMERODROMIINAE) ALONG A STREAM IN SOUTHERN CALIFORNIA

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Abstract.—From May 1996 through April 1998, adult flies in the subfamily Hemerodromiinae were systematically collected with sweep nets along a first-order mountain stream in Southern California. Four genera and eight species were included in the 897 specimens collected. About 78% of the collection was *Neoplasta parahebes* MacDonald & Turner, which was found as early as March and as late as December with a maximum abundance in June and July. Sex ratios for *N. parahebes* (55% females) were consistent with other empidid studies. *Neoplasta scapularis* (Loew) and *Metacheta albipes* Walker were male dominated (68% and 67% males respectively), with a bimodal seasonal distribution (early summer and fall) that suggested a migratory pattern. *Chelifera lovetti* Melander appeared only in the spring while *Chelifera neangusta* MacDonald was found only in the fall.

Key Words.—Insecta, Diptera, Empididae, Hemerodromiinae, phenology, California.

During the last ten years MacDonald (1989, 1993, 1994, 1998), and MacDonald & Turner (1993) reviewed the systematics of the nearctic Hemerodromiinae. Twenty-seven new species were described, increasing to 66 the known North American species of this subfamily. Except for this systematic achievement, the biology of the Hemerodromiinae remains poorly known. Valliant (1953) established larvae of *Hemerodromia* (*Metachela*) *sequyi* Valliant as predators of immature *Simulium* Latreille in an Algerian stream and Peterson (1960) observed adults of *Metachela collusor* Melander and *Neoplasta scapularis* (Loew) feeding on adult black flies in Utah, thus demonstrating them as natural enemies of these pests. Yet, observations remain unusual and collections of most Hemerodromiinae are sporadic and rare. For example, MacDonald (1994) reported that six new species of *Chelifera* Macquart were described from 1 to 3 individuals.

The most comprehensive field study of the Hemerodromiinae from North America found 14 species from the Laurentian Watershed of Québec (Harper 1980). In a smaller scale study Landry & Harper (1985) found 7 species from the Rivière du Castor drainage in Québec. Through a large number of species of Hemerodromiinae have been described from the western United States, no systematic field observations exist. This study was initiated at a site were numerous larval empidids were known to occur (Harkrider 2000). This paper documents the seasonal occurrence of adult dance flies (Diptera: Empididae) in the subfamily Hemerodromiinae along a first order stream in the mountains of Southern California.

METHODS AND MATERIALS

Study Site.—Systematic sampling was conducted along a first order stream in the San Gabriel Mountains of Southern California. A permanent spring provides water all year at 13°–16° C depending on the season. The site was located above the west bank of San Antonio Creek where the water runs parallel to the creek through alluvial deposits. The elevation was approximately 1300 meters. The site was located 300–350 meters north of the highway bridge on the north side of Baldy Village (lat 34°14′25″ N, 117°39′10″ W). The surrounding vegetation was dominated by live oak (*Quercus chrysolepis* Liebmann) and alder (*Alnus rhombifolia* Nuttall). An unusual feature of this site was the presence of numerous California laurel trees (*Umbellularia californica* Nuttall) along the water-course.

Sampling.—Sweep net samples were taken from branches of *U. californica* that overhung the stream. Because other overhanging vegetation was deciduous, only the California Laurel provided a relatively constant sampling substrate throughout the year. Eight sites along of the stream were sampled twice with 8 sweeps each. Adult empidids were collected in 5 dram vials and returned to the laboratory for identification. The sites were sampled at approximately two week intervals from May 1996 through April 1998.

RESULTS

Eight species of Hemerodromiinae were represented among the 897 specimens collected along the stream. Adults were found as early as March and as late as December though the peak abundance occurred from May through July (Table 1).

Neoplasta parahebes MacDonald & Turner was the most abundant species and accounted for 78% of the collection. Figure 1 illustrates that *N. parahebes* males appeared before females with a peak abundance in May while the female population peaked in July. The population declined significantly in the fall, but individuals were found as late as December.

Six *Neoplasta hebes* Melander males were collected compared to 311 *N. parahebes* males. It is not possible to distinguish females of the two species and all females of the *N. hebes* complex were plotted on the graph with *N. parahebes* males. Undoubtedly this leads to an error in the number of females of *N. parahebes.* If female *N. hebes* occur at the same frequency as males, that would mean that approximately 7 females are incorrectly plotted on Fig. 1. Males of *N. hebes* occurred early in March and April and reappeared in September and October. The small numbers suggest this species is a minor component of this community.

Neoplasta scapularis (Loew) accounts for 16% of the dance flies collected. Although this species appears as early as March, the bulk of the population appears later than *N. parahebes* and reaches a peak abundance in July (Fig. 1). Males of *N. scapularis* appear to have a second and greater peak of abundance in September, a pattern that appeared during both years of the survey. The seasonal abundance of *N. scapularis* females generally followed that of the males, although the earliest specimens in 1997 were female.

Metachela albipes Walker has a bimodal distribution appearing in May and flying through early July in 1996. They disappeared through mid-summer and reappeared from September through December.

Two species of *Chelifera* occurred at the site. *Chelifera lovetti* Melander occurred in early June into July, a seasonal pattern widely reported for aquatic empidids. *Chelifera neangusta* MacDonald, however, only appeared from September to December. Finally, one female (not identifiable to species) *Hemerodromia* Meigen was collected in June 1996, and a male of *Metachela collusor* (Melander) was caught in September 1997.

Table 1. Number of empidid flies collected per month. Data reported as #males/#females.

Species	Year	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Species
Neoplasta parahebes	1996			63/22	65/77	14/56	11/11	6/6	2/5	1/6	1/2	163/185	
	1997	6/1	41/15	44/25	9/38	12/71	9/27	3/6	3/3	3/10		130/196	311/384
	1998	5/0	13/3									18/3	
Neoplasta scapularis	1996				11/3	9/3	2/4	13/1	3/0	0/1	1/0	39/12	
	1997	0/2	2/1	0/3	5/3	11/2	4/8	14/6	4/1	4/1		44/27	83/39
Neoplasta hebes	1996						1/0	2/0				3/0	
	1997	2/0	1/0									3/0	6/0
Chelifera lovetti	1996				3/3	1/4						4/7	
	1997		1/0	3/1	0/2	3/3						7/6	11/13
Chelifera neangusta	1996							1/0	0/1		0/1	1/2	
	1997							1/0	1/0			2/0	3/2
Metachela albipes	1996				3/1		1/0	4/2	3/3	0/1	1/1	12/8	
	1997		1/0	3/0				2/0	4/4	6/2	1/0	17/6	29/14
Metachela collusor	1997								1/0		1/0	1/0	
Hemerodromia sp.	1996				0/1							0/1	0/1
Total for all species													444/453

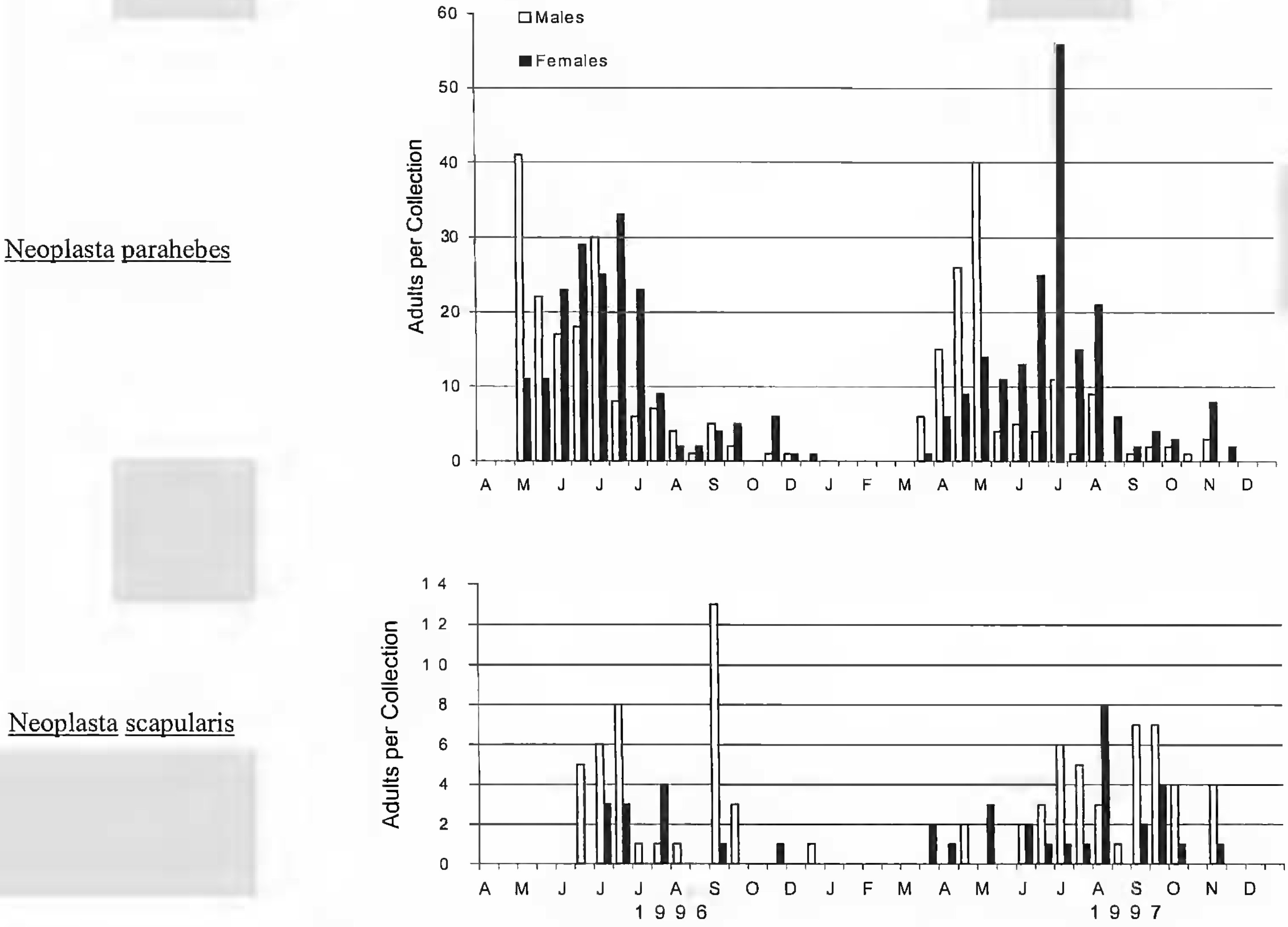

Figure 1. Seasonal distribution of the two most common empidid species in the study area during 1996 and 1997.

DISCUSSION

The occurrence of eight species of Hemerodromiinae in this habitat is consistent with similar studies in the temperate region. Harper (1980) found 14 species of the Hemerodromiinae, but his was an extensive study that included 27 sites and 73 trap-years. Even in this extensive study seven species were represented by less than 10 specimens and three species by only one specimen. In three years of collecting from the Rivière du Castor drainage in Québec, Landry & Harper (1985) found only 7 species of Hemerodromiinae. In Germany, Caspers & Wagner (1982) studied a woodland stream near Bonn, and in Austria, two streams were systematically collected by Wagner (1982). In all these cases only 6 to 8 species of Hemerodromiinae were observed per site. Tropical regions appear to have less diversity of this subfamily. Masteller & Busby (1993) reported only two species of emergent empidids from a rainforest stream in Puerto Rico.

A obvious result of this survey was the dominance of a single species, *N. parahebes* (78% of collection). This is not unprecedented. In the Laundry & Harper (1985) study in Québec, *N. scapularis* made up 80% of the Hemerodromiinae collected. In the two European studies cited above, over 80% of the collection consisted of two dominant species, rather than one.

An unusual aspect of this study was the sex ratio of the various species (Table 1) Virtually all other studies report a larger percentage of females than males. Masteller & Busby (1993) document 71% females in Puerto Rico and 52.5% females were captured by Casper & Wagner (1982) in Germany; the results of other emergence studies fell between these two figures. In this study, only *N. parahebes* and *C. lovetti* collections had more females than males. The relatively low ratio of females was presumably due to the method of collection. Virtually all of the reported studies have used emergence traps rather than sweeping vegetation. However, both Landry & Harper (1985) and Harper (1980) used vegetation sweeps in part of their collection. In Landry & Harper (1985), emergence traps caught 68% females while sweep nets caught 54% females. The sex ratios of *N. parahebes* (55% females) and *C. lovetti* (54% females) from San Antonio Creek are consistent with those obtained with sweep nets in the Canadian study. I have reared numerous *N. parahebes* larvae from the stream at the collection sites (Harkrider 2000), and know the stream to be an emergence site for this species. However, the male dominant *N. scapularis* (68% males) and *M. albipes* (67% males) were aberrant. *Neoplasta scapularis* adults have been reared from larvae collected in San Antonio Creek to the east of the site (unpublished) but only once from the collecting site (Harkrider 2000). Perhaps the higher proportion of males was associated with migration. If so, this may explain the bimodal distribution of *N. scapularis* and *M. albipes. Neoplasta scapularis* males showed peak abundance in June–July and again during September. Similarly, in both years, *M. albipes* appeared from late April to June and reappeared, in greater numbers, from late September to October. The two periods of abundance might represent two periods of peak emergence for both species. However, particularly considering the skewed sex ratios, the fall peak could be associated with a season migration to this perennial stream as surrounding lotic sites become dry.

Chelifera species appear seasonal and temporally isolated. *Chelifera lovetti* occurs in early summer consistent with other studies of *Chelifera* species. *Chelifera neangusta* appears only in the fall. MacDonald (1994) described this species from only two specimens. Perhaps the rarity of this species in collections is associated with the late emergence, a time collectors do not generally look for aquatic dance flies.

Adults of Hemerodromiinae along San Antonio Creek were found over a ten-month period each year during the study. In Puerto Rico, *Hemerodromia* species emerged all year, though emergence was slight in July and August. In the Canadian studies the emergence period was restricted to June through September. The results of this study can not be directly compared to the others because most other studies measured emergence, where as this study documented the presence of adults in the environment. The relatively mild winters in the Mediterranean climate of southern California may have resulted in a longer period of emergence, as documented in the tropics, or perhaps the lack of severe cold allows a longer life expectancy than the more northern climates. Indeed, during the mild "la niña" winter of 1999, adults of the two dominate species in this study were caught as late as January and February. Further investigation is required.

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